432 and 440 Hz Music on Focus and Attention in ADHD Children- Does pitch matter in Music Therapy for ADHD?

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Abstract: Music has been a powerful instrumental voice that produces physiological, psychological, and social effects (Hodges, 1996; Davis et al., 2008; Thaut and Hoemberg, 2014; Wheeler, 2015). Several studies have reported that music interventions may have a positive impact on ADHD[1] patients. ADHD is a disorder marked by a pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development.[2] Attention is a fundamental skill that is essential for cognitive development and, hence, has an important role in cognitive, social, and communication development (Muris, 2006; van de Weijer-Bergsma et al., 2008; Cornish and Wilding, 2010; Matson et al., 2010; Rueda et al., 2010; Janzen and Thaut, 2018). However, music is not only just melody, but it is also the science of acoustics, including frequency,[3] hertz,[4] pitch,[5,] etc. Recently, there has been a lot of debate, discussion, and research that lower pitch sounds have a calming effect on the brain and even help in sleep. Music therapy intervention has been known to be beneficial in patients with ADHD for focus and attention but now we must ask ourselves the following question: what is the ideal for music or what is the ideal pitch for music intended for music therapy in this group of patients? On April 9, 1988, in Milan, Italy, the Schiller Institute held a conference that was attended by world-renowned opera and classical singers for changing the standard pitch from 440 Hz to 432 Hz. The main outcome there was that in the traditional *Bel Canto* technique, passed down the centuries from the Italian masters, a specific shift occurs in the voices of the tenors and sopranos. This naturally happens on the F# when instruments are tuned to A = 432 Hz. When instruments are tuned to 440 Hz or higher, then the shift will occur around note F or even lower. The Schiller Institute maintains that the operas of the great composers of the past were composed on a lower pitch. In opera singing, the shifts in the voice were used to highlight the meaning of the lyrics; therefore, these changes have to occur on the perfect notes. The human voice is ultimately the basis of human music. Musical instruments came much

later and their technical issues and specifications should not be allowed to hold precedence over the natural needs of the human voice (The Science of Music). We proposed to examine the genre/pitch of music that children with ADHD prefer to listen to, demonstrating improvement in attention with lower pitch music.

Material and Methods: After informed consent was obtained verbally from the guardian, we collected data from a small sample size of 18 patients in a rural health clinic in Georgia. Data was collected as to which music genre helped in improving focus and attention on a scale of 1-10.

This genre was then placed into lower pitch (Classical, Country, Religious/Gospel, and R&B/Soul) and higher pitch (Video game music/Electronic, Hip-Hop/Rap, and Modern Pop) categories. All demographics are tabulated below in Table 1. Subsequent analysis were then performed for change of focus with the different music pitch categories based on age range, sex, race and whether on oral medications or not.

Table 1- Demographics of patient population

N=18			
Age range	<11yrs: 10	11-13yrs: 3	>13 yrs: 5
Race	aucasian- 10	Hispanic- 1	African-American- 7
Sex	Female- 6	Male- 12	
On treatment?	Yes- 4	No- 14	

Results:

Findings from our data collection show that pediatric patients who preferred lower pitch music showed significant improvement in attention and focus. Table 2 shows the total no of patients with preference for lower pitch music who demonstrated more focusing ability (reported as > or = 7 on a scale of 1-10) irrespective of sex (Table 3), race (Table 4), medications (Table 5), and age group (Table 6).

Table 2: Showing total number of patients with change in focus with lower pitch music

Prefer lower pitch Music	AVERAGE of Focus (1-10)	No. of Patients
No	3.7	6
Yes	8.2	12

Table 3: Change in focus with lower pitch music based on sex

Sex	*Prefer lower pitch Music*	Average of Focus (1-10)	No. of Patients
F	No	5.0	2
	Yes	8.0	4
M	No	3.0	4
	Yes	8.3	8

Table 4: Showing Change in focus with lower pitch music based on race

Race	*Prefer lower pitch music*	AVERAGE of Focus (1-10)	No. of Patient #
African American	No	4.7	3
	Yes	9.0	4
Hispanic / Latino	Yes	8.0	1
White	No	2.7	3
	Yes	7.7	7

Table 5:Showing Change in focus with lower pitch music based on medication treatment

On Medications?	*Prefer lower pitch Music*	VERAGE of Focus (1-10)	OUNT of Patient #
No	No	3.0	4
	Yes	8.3	10
Yes	No	5.0	2
	Yes	7.5	2

Table 6:Showing Change in focus with lower pitch music based on age groups

Age	*refer lower pitch Music*	AVERAGE of Focus (1-10)	UNT of Patient #
[1] <11	No	4.2	5
	Yes	7.8	6
[2] 11-13	No	1.0	1
	Yes	9.5	2
[3] >13	Yes	8.0	4

Discussion: Although ADHD is a multifactorial disorder, it is predominantly a dysfunction of the prefrontal cortex that results in a lack of alertness, or shortened attention span; it is also associated with abnormally low levels and/or disrupted neurotransmitters dopamine and serotonin, which transmit between the prefrontal cortical area and the basal ganglia and, hence, play an important role in its pathophysiology. (Blum et al., 2008; Misener et al. 2004). Blood and Zatorre (2001) used PET (Positron Emission Tomography) scanning of the brain to quantify changes in cerebral blood flow while participants listened to music which gave them any sort of “intensely pleasant emotional response,” found that as these emotions increase, significant changes in cerebral blood flow were noted in brain regions such as the prefrontal cortex along with the release of dopamine, serotonin, and oxytocin. This implies that choosing the correct music pitch to bring about this positive response in the prefrontal cortex along with the release of dopamine and serotonin may be key in music therapy for ADHD patients.

Research has suggested that Mozart’s music may show a short-term improvement in the performance of certain kinds of mental work known as “spatial-temporal reasoning” (Jenkins, 2001). This has been called the “Mozart Effect”; although there is considerable controversy about just how effective classical music may be for improving cognitive functioning, it is clearly evident that it is highly effective for eliminating distractions and boosting what’s called “enjoyment arousal”, which can help focus and increase attention span. We saw

a positive effect on our patients who listened to classical music (lower pitch category)- clearly eliciting the Mozart effect in our ADHD population.

Historically, music was recorded and mixed in 432 Hertz (Hz). Hz is the metric unit of frequency, frequency is the number of vibrations or sound waves per second. In the past, most classical music and R&B songs were recorded at 432 Hz which gives them a pleasant and soothing tone. German physicist Winfried Otto postulated that the earth has a frequency of 8 Hz, or in other words, the earth's surface vibrates eight times a second. If eight Hz is considered to be the starting point and frequency is changed upwards by five octaves, the frequency is 256 Hz on whose scale the note A has a frequency of 432 Hz. Octaves are a series of notes between two different pitches; one pitch has half the frequency of the other. So at the fifth octave, the musical note "A" has a frequency of 432 Hz. The center of the earth's vibration creates a tone that causes relaxation of the human brain. As described in music theory, A=432 Hz is said to be mathematically consistent with the universe and is known as Verdi's 'A' – named after Giuseppe Verdi, a famous Italian composer. In 1953, an international agreement was made where "A" note should be tuned to a frequency of 440 Hz (ISO, 1975). There has been some discussion and debate over music created with a frequency of 440 Hz, that is even a small difference of 8 Hz or more not only can eliminate the previously described harmonization with the earth but with this vibrational pattern may stimulate the brain in opposing ways to relaxation.

Mathematical analysis is based on a system called "Pythagorean tuning," a system of musical tuning in which the frequency ratios of all intervals are based on the ratio 3:2. This ratio which has been called the perfect fifth is one of the most "consonant and easiest to tune by ear" due to the importance given to the integer 3 (Lloyd, 1940). This "Pythagorean tuning" was used by earlier musicians up until the beginning of the 16th century. Pythagorean tuning follows a theory of a cycle of perfect fifths; a perfect musical fifth is defined by the ratio 3/2. So, going over the math shows 256 X 3/2 = 384 Hz (G4). 384 X 3/2 = 576 Hz (D5). 576 X 3/2 = 864 Hz (A5: one octave higher than A4 at 432 Hz). Because the 12-tone Pythagorean temperament is in the ratio of 3:2, it sounds very "smooth" and consonant. However, "the Pythagorean system would appear to be ideal because of the purity of the fifths, but some consider other intervals, particularly the major third, to be so badly out of tune that major chords [may be considered as] a dissonance" (Benward & Saker, 2003).

Violinist Maria Renold conducted many experiments testing listeners' responses to her tuning system in both 440 Hz and 432 Hz. She found that "*of 2000 people tested over 20 years, over 90% consistently preferred the lower pitch. The notes were given in different order, on different instruments, with various means to avoid prejudicing the listener. The wide variety of comments all went in the similar direction of calling the higher pitch more "irritating, unpleasant, aggressive, making one stressful and nervous." The lower one, on the other hand, sounded "right, complete, pleasant, radiant, peaceful, harmonious, heartfelt but leaving one free"* (Renold, Stevens, & Meuss, 2004). Limited researchers of the lower hertz claim that listeners of music that lean more towards slow and contemporary ie 432 Hz tend to experience a slower pulse and heart rate, lower blood pressure, and decreased levels of stress hormones even when having medical procedures or examinations (Di Nasso, 2016; Calamassi & Pomponi, 2019). Our study clearly elicits this as our ADHD patients who preferred to listen to music in this lower pitch zone (classical/R&B/Soul/Religious) reported significant improvement in their attention and focus whereas subjects who preferred music in the higher frequency zone (VideoGame/Electronic) definitely reported no benefit of music on their attention span.

All of the above suggest that probably finding the right pitch to promote the adequate release of neurotransmitters and stimulation of the appropriate area of the brain may be the key to music therapy in ADHD patients. So, is 432 Hz the magic pitch that should be used in music therapy intervention?

Conclusion:

How this affects the musical industry, music recording, and ultimately music therapy remains a question. Should music therapists choose instrumental music recorded at 432Hz only? Should vocalists for music therapy shift voices as per the Bel Canto technique? The concept of binaural beats is another area that may have a role in the ADHD population where research is limited at the current time but remains a new concept to be explored in this era where a difference in hertz whether it is 30Hz (as defined by binaural beats) or 8Hz (that is 432 vs 440 Hz) that can bring about a musical and therapeutic revolution in this particular population (Kennel et al., 2010). Although our study is limited by the number of subjects, it definitely shows the beneficial effect of lower pitch music. More research with a large number of subjects is needed to further analyze and

establish the ideal tonal frequency for music recording for instrumental, vocal, or both that are beneficial for music therapy in ADHD patients.

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